OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **Mirror Lake, Tuftonboro,** the program coordinators have made the following observations and recommendations.

Thank you for your continued hard work sampling the tributaries this year! Your monitoring group sampled the tributaries **ten** times this year and has done so for four years! As you know, conducting multiple sampling events each year enables DES to more accurately detect water quality changes. Keep up the great work!

If your monitoring group's sampling events this year were limited due to not having enough time to pick-up or drop-off samples at the Limnology Center in Concord, please remember the Plymouth State University Center for the Environment Satellite Laboratory is open in Plymouth. This laboratory was established to serve the large number of lakes/ponds in the greater North region of the state. This laboratory is inspected by DES and operates under a DES approved quality assurance plan. We encourage your monitoring group to utilize this laboratory next summer for all sampling events, except for the annual DES biologist visit. To find out more about the Center for the Environment Satellite Laboratory, and/or to schedule dates to pick up bottles and equipment, please call Aaron Johnson, laboratory manager, at (603) 535-3269.

In 2009, the Mirror Lake Protective Association applied to DES for EPA Section 319 restoration grant funding to develop a watershed management plan for Mirror Lake, which has documented potentially toxic cyanobacteria blooms the past few years. DES awarded $65,000 in Section 319 funds to the Mirror Lake Protective Association in 2010.

The Mirror Lake Protective Association hired an Environmental Consultant, Geosyntec, in 2010 to assist coordinating and developing the watershed management plan. The MLPA anticipates completing the watershed management plan in early 2011.

Quality assurance plans and subsequent water quality testing and analysis have been developed for watershed modeling, in-lake water quality and internal phosphorus loading. A quality assurance plan for in-lake sediment and watershed soil testing is pending, but anticipated to be completed by early 2011.

FIGURE AND TABLE INTERPRETATION (DEEP SPOT SAMPLING)

CHLOROPHYLL-A

- Table 1 in Appendix B lists the minimum, maximum, and mean concentration for each year that the lake has been monitored through VLAP.

  Chlorophyll-a, a pigment found in plants, is an indicator of the algal abundance. Algae (also known as phytoplankton) are typically microscopic, chlorophyll producing plants that naturally occur in lake ecosystems. The chlorophyll-a concentration measured in the water gives biologists an estimation of the algal concentration or lake productivity. **The median summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 4.58 mg/m^3.**

  Chlorophyll-a data are not available for 2010. Deep spot sampling is not conducted as part of the routine VLAP sampling for Mirror Lake.

PHYTOPLANKTON

- Table 2 in Appendix B lists the current and historical phytoplankton and/or cyanobacteria observed in the lake. Specifically, this table lists the three most dominant phytoplankton and/or cyanobacteria observed in the sample and their relative abundance in the sample.

  Phytoplankton data are not available for 2010. Deep spot sampling is not conducted as part of the routine VLAP sampling for Mirror Lake.

TRANSPARENCY

- Table 3a in Appendix B lists the minimum, maximum and mean transparency data without the use of a viewscope and Table 3b lists the minimum, maximum and mean transparency data with the use of a viewscope for each year that the lake has been monitored through VLAP.

  Volunteer monitors use the Secchi disk, a 20 cm disk with alternating black and white quadrants, to measure how far a person can see into the water. Transparency, a measure of water clarity, can be affected by the amount of algae and sediment in the water, as well as the natural lake color of the water. **The median summer transparency for New Hampshire's lakes and ponds is 3.2 meters.**

Transparency data are not available for 2010. Deep spot sampling is not conducted as part of the routine VLAP sampling for Mirror Lake.

ACID NEUTRALIZING CAPACITY

- Table 5 in Appendix B presents the current year and historical epilimnetic ANC for each year the lake has been monitored through VLAP.

  Buffering capacity (ANC) describes the ability of a solution to resist changes in pH by neutralizing the acidic input. The median ANC value for New Hampshire's lakes and ponds is **4.8 mg/L**, which indicates that many lakes and ponds in the state are at least "moderately vulnerable" to acidic inputs. For a more detailed explanation about ANC, please refer to the "Chemical Monitoring Parameters" section of this report.

  ANC data are not available for 2010. Deep spot sampling is not conducted as part of the routine VLAP sampling for Mirror Lake.

TOTAL PHOSPHORUS

- Table 8 in Appendix B lists the annual minimum, maximum, and median concentration for each deep spot layer and each tributary since the lake has been sampled through VLAP.

  Phosphorus is typically the limiting nutrient for vascular aquatic plant and algae growth in New Hampshire's lakes and ponds. Excessive phosphorus in a lake or pond can lead to increased plant and algal growth over time. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 12 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

  Total phosphorus data are not available for 2010. Deep spot sampling is not conducted as part of the routine VLAP sampling for Mirror Lake.

DISSOLVED OXYGEN AND TEMPERATURE

- Table 9 in Appendix B shows the dissolved oxygen/temperature profile(s) collected during **2010**. Table 10 in Appendix B shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of sufficient amounts of dissolved oxygen in the water column is vital to fish and amphibians and bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

Dissolved oxygen and temperature data are not available for 2010. Deep spot sampling is not conducted as part of the routine VLAP sampling for Mirror Lake.

FIGURE AND TABLE INTERPRETATION (TRIBUTARY SAMPLING)

pH

- Figure 1 in Appendix A and Table 4 in Appendix B presents the historical and current year tributary pH data.

  pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 6.0 typically limits the growth and reproduction of fish. A pH between 6.0 and 7.0 is ideal for fish. The median pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.6**, which indicates that the state surface waters are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

  The mean pH of the tributary stations ranged from **5.98** to **6.76** which indicates that the water is ***slightly acidic***.

  The pH tended to be more acidic in the winter months. This is likely due to any snowmelt reaching the tributaries. Winter precipitation (typically in the form of snow) generally has a pH between 4.0 and 5.0. As this melts, it can temporarily decrease pH levels in tributaries and lakes.

CONDUCTIVITY

- Figure 3 in Appendix A and Table 6 in Appendix B presents the current and historical tributary conductivity values. Conductivity is the numerical expression of the ability of water to carry an electric current, which is determined by the number of negatively charged ions from metals, salts, and minerals in the water column. The median conductivity value for New Hampshire's lakes and ponds is

40.0 uMhos/cm. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean conductivity at the tributary stations ranged from **72.3 to 116.6 uMhos/cm**, which is ***greater than*** the state median. The tributary conductivity has ***decreased*** (meaning ***improved***) since monitoring began. This ***decreasing*** conductivity trend suggests the reduction of pollutants and erosion in the watershed. We hope that this improving trend continues!

However, conductivity levels continue to remain ***elevated*** in the tributary system. Elevated conductivity typically indicates the influence of human activities on surface water quality. Septic system leachate, agricultural runoff, iron deposits, and road runoff which typically contains road salt during the spring snow melt, can each influence conductivity readings.

In general, tributary conductivity levels increased gradually as the summer progressed, most likely due to low stream flow concentrating minerals and nutrients in the system. Rain events in the fall restored flow resulting in decreased conductivity levels.

It is likely that de-icing materials applied to nearby roadways during the winter months may be influencing the conductivity in the lake. In New Hampshire, the most commonly used de-icing material is salt (sodium chloride).

Therefore, we recommend that the tributary system continue to be sampled for chloride next year. This additional sampling may help us identify what areas of the watershed are contributing to the increasing in-lake conductivity.

Please note that the DES Limnology Center in Concord is able to conduct chloride analyses, free of charge. As a reminder, it is best to conduct chloride sampling in the spring as the snow is melting and during rain events.

TOTAL PHOSPHORUS

- Figure 2 in Appendix A and Table 8 in Appendix B presents the current year and historical tributary total phosphorus data. Phosphorus is the nutrient that limits the ability of algae and aquatic plants to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

The phosphorus concentration in **Abenaki Lagoon** ranged from **21 to 67 ug/L** in 2010. Phosphorus concentrations were ***slightly elevated*** throughout the year. Turbidity levels were also ***slightly elevated***. Dry weather conditions in 2010 likely contributed to lower water levels in the lagoon and also concentrated nutrient levels and algal growth. Overall, phosphorus concentrations continue to be slightly elevated in the lagoon but are relatively stable throughout the year.

The phosphorus concentration in **Waumbeck Rd** ranged from **18 to 37 ug/L** in 2010. Phosphorus concentrations were ***elevated*** in **March, June and July**. Turbidity levels were also ***elevated***. Dry weather conditions likely contributed to low stream flow which concentrated nutrients in the system and elevated phosphorus concentrations in June and July. Tributary flows likely increased with fall rain events and phosphorus concentrations decreased in September, October and November. Overall phosphorus concentrations continue to be slightly elevated but remain relatively stable throughout the year.

The phosphorus concentration on the **August** sampling event (**180 ug/L**) is not here reported as the sample was contaminated with sediment (turbidity **12.1 NTUs**). Sediment and organic debris contain phosphorus. When collecting tributary samples, please be sure to sample where the tributary is flowing and where the stream is deep enough to collect a “clean” sample free from organic debris and sediment.

The phosphorus concentration in **West Inlet A** ranged from **15 to 53 ug/L**, and phosphorus concentrations in **West Inlet B** ranged from **15 to 62 ug/L** in 2010. Phosphorus concentrations at both stations were ***elevated*** from **June** through **September**, likely due to low stream flows. Turbidity levels were also ***elevated*** during this period. When collecting tributary samples, please be sure to sample where the tributary is flowing and where the stream is deep enough to collect a “clean” sample free from organic debris and sediment. Overall, phosphorus concentrations tend to peak during the summer months but are stable in the fall and winter.

The phosphorus concentration in **East Inlet** ranged from **17 to 96 ug/L** in 2010. Phosphorus concentrations were ***elevated*** from **June** through **October**, likely due to low stream flows. Turbidity levels were also ***elevated*** during this period. When collecting tributary samples, please be sure to sample where the tributary is flowing and where the stream is deep enough to collect a “clean” sample free from organic debris and sediment. Overall, phosphorus concentrations tend to peak during the summer months and generally fluctuate throughout the year.

The phosphorus concentration on the **August** sampling event (**390 ug/L**) is not here reported as the sample was contaminated with sediment (turbidity **50 NTUs**). Sediment and organic debris contain phosphorus. When collecting tributary samples, please be sure to sample where the tributary is flowing and where the stream is deep enough to collect a "clean" sample free from organic debris and sediment.

- **Table 11: Turbidity**

  Figure 4 in Appendix A and Table 11 in Appendix B lists the current year and historical tributary turbidity data. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the "Other Monitoring Parameters" section of this report for a more detailed explanation.

  The turbidity in the **Abenaki Lagoon** samples was ***slightly elevated*** on the **March, April, May, June, July, and November** sampling events. The turbidity was also ***elevated*** (**7.6 NTUs**) on the **August** sampling event. This suggests that sediment and/or lagoon algal growth may have contributed to the elevated turbidity levels. Sediment, which typically contains attached phosphorus, and algae, which typically contains cellular phosphorus can elevated turbidity and phosphorus levels in a system. When collecting tributary samples please sample where there's sufficient stream flow and depth to collect a "clean" sample free from organic debris and sediment.

  The turbidity in the **Waumbeck Rd.** samples was ***slightly elevated*** on the **March, April, May, July, and September** sampling events. The turbidity was also ***elevated*** (**6.78 and 12.1 NTUs**) on the **June and August** sampling events. Dry weather conditions likely contributed to low tributary flow. This suggests that the stream bottom may have been disturbed while sampling. When collecting tributary samples please sample where there's sufficient stream flow and depth to collect a "clean" sample free from organic debris and sediment.

  The turbidity in the **West Inlet A** samples was ***slightly elevated*** on the **March, April, May, June, July, August, September and November** sampling events. Dry weather conditions likely contributed to low tributary flow. This suggests that the stream bottom may have been disturbed while sampling. When collecting tributary samples please sample where there's sufficient stream flow and depth to collect a "clean" sample free from organic debris and sediment.

The turbidity in the **East Inlet** samples was ***slightly elevated*** on the **March, August and September** sampling events. The turbidity was also ***elevated*** (**50 and 6.73 NTUs**) on the **January and July** sampling events. Dry weather conditions likely contributed to low tributary flow. This suggests that the stream bottom may have been disturbed while sampling. When collecting tributary samples please sample where there's sufficient stream flow and depth to collect a "clean" sample free from organic debris and sediment.

BACTERIA (*E. COLI*)

- Table 12 in Appendix B lists the current year and historical data for bacteria *(E.coli*) testing. *E. coli* is a normal bacterium found in the large intestine of humans and other warm-blooded animals. *E.coli* is used as an indicator organism because it is easily cultured and its presence in the water, in defined amounts, indicates that sewage **may** be present. If sewage is present in the water, potentially harmful disease-causing organisms **may** also be present.

  Bacteria sampling was not conducted this year. If residents are concerned about sources of bacteria such as failing septic systems, animal waste, or waterfowl waste, it is best to conduct *E. coli* testing when the water table is high, when beach use is heavy, or immediately after rain events.

CHLORIDE

- Figure 5 in Appendix A and Table 13 in Appendix B lists the current year and the historical tributary chloride data. The chloride ion (Cl^-) is found naturally in some surfacewaters and groundwaters and in high concentrations in seawater. Research has shown that elevated chloride levels can be toxic to freshwater aquatic life. In order to protect freshwater aquatic life in New Hampshire, the state has adopted **acute and chronic** chloride criteria of **860 and 230 mg/L** respectively. The chloride content in New Hampshire lakes is naturally low, generally less than 2 mg/L in surface waters located in remote areas away from habitation. Higher values are generally associated with salted highways and, to a lesser extent, with septic inputs. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  Overall, chloride levels have ***decreased*** in the tributary system similar to the decreasing conductivity levels.

Abenaki Lagoon was sampled for chloride on each sampling event. The results ranged from **8.8 to 19 mg/L**, which is ***much less than*** the state acute and chronic chloride criteria. However this number is ***greater than*** what we would normally expect in undisturbed New Hampshire surface waters.

Waumbeck Rd. was sampled for chloride on each sampling event. The results ranged from **4.7 to 26 mg/L**, which is ***much less than*** the state acute and chronic chloride criteria. However this number is ***greater than*** what we would normally expect in undisturbed New Hampshire surface waters.

West Inlet A was sampled for chloride on each sampling event. The results ranged from **9.3 to 28 mg/L**, which is ***much less than*** the state acute and chronic chloride criteria. However this number is ***greater than*** what we would normally expect in undisturbed New Hampshire surface waters.

West Inlet B was sampled for chloride on each sampling event. The results ranged from **9.6 to 24 mg/L**, which is ***much less than*** the state acute and chronic chloride criteria. However this number is ***greater than*** what we would normally expect in undisturbed New Hampshire surface waters.

East Inlet was sampled for chloride on each sampling event. The results ranged from **3.3 to 10 mg/L**, which is ***much less than*** the state acute and chronic chloride criteria. However this number is ***greater than*** what we would normally expect in undisturbed New Hampshire surface waters.

Overall, chloride concentrations tend to increase during the summer months. We suspect groundwater contributions may be elevating chloride concentrations during this period. Chloride levels have ***decreased*** in the tributary system similar to the decreasing conductivity levels. **Abenaki Lagoon** has experienced the most marked decrease in chloride levels since monitoring began. We hope this decreasing trend continues!

We recommend that your monitoring group continue to conduct chloride sampling in the tributaries. This will continue to establish a baseline of data that will assist your monitoring group and DES to determine water quality trends in the future.

Please note that chloride analyses can be run free of charge at the DES Limnology Center. Please contact the VLAP Coordinator if you are interested in chloride monitoring. In addition, it is best to conduct chloride sampling in the spring as the snow is melting and during rain events.

- **Table 14: Current Year Biological and Chemical Raw Data**
  Table 14 in Appendix B lists the most current sampling year results. Since the maximum, minimum, and annual mean values for each parameter are not shown on this table, this table displays the current year "raw," meaning unprocessed, data. The results are sorted by station, depth, and then parameter.

- **Table 15: Station Table**
  As of the spring of 2004, all historical and current year VLAP data are included in the DES Environmental Monitoring Database (EMD). To facilitate the transfer of VLAP data into the EMD, a new station identification system had to be developed. While volunteer monitoring groups can still use the sampling station names that they have used in the past and are most familiar with, an EMD station name also exists for each VLAP sampling location. Table 15 in Appendix B identifies what EMD station name corresponds to the station names you have used in the past and will continue to use in the future.

DATA QUALITY ASSURANCE AND CONTROL

An annual biologist visit was not conducted in 2010. Please contact the VLAP coordinator in 2011 to schedule your biologist visit.

Sample Receipt Checklist:

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if your group followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did a ***very good*** job when collecting samples this year! Specifically, the members of your monitoring group followed the majority of the proper field sampling procedures when collecting and submitting samples to the laboratory. However, the laboratory did identify a few aspects of sample collection that your group could improve upon, as follows:

- **Tributary sampling:** Please do not sample tributaries that are not flowing. Due to the lack of flushing, stagnant water typically contains ***elevated*** amounts of chemical and biological constituents that will lead to results that are not representative of the quality of water that typically flows into the lake.

USEFUL RESOURCES

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, DES Booklet WD-03-42, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-03-42.pdf.

Iron Bacteria in Surface Water, DES fact sheet WD-BB-18, (603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/factsheets/bb/documents/bb-18.pdf.

Low Impact Development Hydrologic Analysis. Manual prepared by Prince George's County, Maryland, Department of Environmental Resources. July 1999. To access this document, visit www.epa.gov/owow/nps/lid_hydr.pdf or call the EPA Water Resource Center at (202) 566-1736.

Low Impact Development: Taking Steps to Protect New Hampshire's Surface Waters, DES fact sheet WD-WMB-17, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-17.pdf.

*NH Stormwater Management Manual Volume 1: Stormwater and Antidegradation, DES fact sheet WD-08-20A, (*603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20a.pdf

NH Stormwater Management Manual Volume 2: Post-Construction Best Management Practices Selection and Design, DES fact sheet WD-08-20B, *(*603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20b.pdf

NH Stormwater Management Manual Volume 3: Erosion and Sediment Controls During Construction, DES fact sheet WD-08-20C, *(*603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20c.pdf

Road Salt and Water Quality, DES fact sheet WD-WMB-4, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-4.pdf.

Watershed Districts and Ordinances, DES fact sheet WD-WMB-16, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-16.pdf.